School of Informatics

Informatics Research Review
The Impact of Multi-Sensory Video Game Interfaces on Players

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Abstract

Most video game designers focus on the visual displays. However, other senses can be stimulated. In this review, we will explore the effects of multi-sensory game interfaces on players. We will see that such type of displays improves players' experience and may revolutionize the way they receive information. We will also mention the controversial effects on performance. Then, we will underline that, if auditory cues are preferred by players, combining different types of stimulations lead to a better experience. Finally, we will highlight the importance of design for such games, especially because of the risk of overwhelming players.

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1 Introduction

Gaming has a certain potential. Initially, it was considered as a way for people to have fun. However, Brox et al. [1] showed that it can serve other purposes such as improving people's health. Indeed, they highlighted the existence of educational games that facilitate learning, of persuasive games that help people quit bad habits and stick to good ones, and of exergames for which playing means exercising. The educational power of games was also underlined by Alpar [2]. She underlined that including games when teaching foreign languages to children was beneficial and gave better results than traditional methods.

Game design choices have an impact on players' experience [1]. And some of those choices concern the senses that will be stimulated. The majority of games rely on players' vision. It can be explained by the fact that visual tools seem more efficient and effective when it comes to sharing information with players. Yet, other senses could also be stimulated. Indeed, audio and haptic elements, for example, could be integrated into games, making their interfaces "multi-sensory". So, understanding the impact of multi-sensory video game interfaces (MSVGIs) could allow game designers to improve players' experience. Besides, in some cases, multi-sensory components are a necessity. For example, Pusateri et al. [3], that studied a game aiming to improve sleep, claimed that "designing for sleep means designing for all five senses".

Moreover, a game interface can be multi-sensory in different ways, and those different ways may have different impacts on players. Understanding these particularities could also contribute to improving video game designs.

So, in this review, we will investigate the effects of MSVGIs on players. And we will examine the relationship between the stimulated senses and the effects on players. We will also highlight the importance of design in those games. We will however not consider the accessibility potential of multi-sensory interfaces. And, we won't discuss the technical tools used to provide those kinds of interfaces.

First, we will focus on the effects of MSVGIs on players' immersion, motivation, and performance. We will observe a clear increase in immersion and motivation and, we will highlight that those interfaces allow game designers to share more information with players. We will also note that the impact on performance is more controversial. Then, we will study the relationship between the effects observed and the senses stimulated. In particular, we will see that combinations of different types of stimulation seem to have better effects and that different senses generate different results. And we will highlight the importance of design for these interfaces, noting the impact that those can have on players' experience.

2 Literature Review

2.1 The Effects of MSVGIs on Players

In this section, we will underline the effects that MSVGIs can have on players. In particular, we will see that the use of this type of interface can have consequences on players' immersion, and motivation and can change the way they receive games-related information. And, we will discuss the different results found concerning the effects of MSVGIs on players' performance.

2.1.1 MSVGIs Increase Players' Immersion and Motivation

Nesbitt and Hoskens [4] showed that MSVGIs increase players' immersion and motivation. Their study evaluated the impact of this type of game interface on players' experience. They asked their participants to play the shooting game Quake 3: Arena in different modes and to rate afterwards their experience in terms of satisfaction, confidence, and immersion. The difference between the modes was the nature of the cues given to the players (visual cues, visual and haptic cues, visual and auditory cues, visual, haptic, and auditory cues). As a result, they found that the multi-sensory modes gave a better experience to the players.

This result was confirmed by Alexander Shaw et al. [5], who also studied the effects of different sensory cues on players. They used a similar methodology than [4], exposing participants to different versions of the same game, and then collecting their impressions. In this case, the game was an exergame (so, a game encouraging the players to exercise). Concerning the versions, there was a version with sound, a version with fan, a version with resistance, and a version that combines sound, fan, and resistance. Eventually, as for [4], they found that MSVGIs resulted in an increased immersion. Moreover, they underlined that an increased immersion induces a higher motivation. This implies that MSVGIs also increase players' motivation.

Furthermore, Salen and Zimmerman, as cited by Nelson and Burkhard [6], underlined that the narrative experience in games can be improved by audio cues. In this case, narrative refers to a "discourse (the telling of a story) containing the existents and events" as defined by Jull, as cited by Jemmali et al. [7]. [7] showed that games' narratives had a positive impact on player's engagement. This finding was the result of a study that split subjects into two groups and gave to each group a different version of the learning game May's Journey. One version had a light narrative and the other a rich one. Questionnaires were also used to complete the data collected. Therefore, MSVGIs improve the narrative experience which improves players' motivation.

Thus, we can see that many papers support the result that MSVGIs increase players' immersion and motivation.

2.1.2 MSVGIs Can Be a Way to Share Information with Players Differently

Ng and Nebsitt [8] advocated for "informative game design". Indeed, they suggested using sounds not only to increase immersion as mentioned before but to give information to the players, such as feedback. Their study analyzed different games using sound in this way. Therefore, MSVGIs interfaces could give game designers the possibility to share information differently, or even share more information with the players.

[5] also used the additional (by that, I mean not visual) sensory cues as a way to give feedback to players. However, unlike [8], that made clear a distinction between immersive sound, which does not give any information, and informative sound, [5] showed that sensory feedbacks, that are informative, caused an increased immersion. This difference can be explained by their different approach. Indeed, [5] ran an empirical study and asked the players about their experience. And on the contrary, [8] studied directly the games themselves and assumed the potential problems that players may encounter and potential solutions. Therefore, [5] results about the effects of informative sensory cues on players' immersion seem more valid.

Brown, Brewster, and Purchase [9] also demonstrated the potential of vibro-tactile interfaces. To do so, they used tactons, tactile icons, to send messages to subjcets, and then, they evaluated the understanding of those messages. They obtained an "overall recognition rate of 71%".

Therefore, vibro-tactile interfaces could be an effective communication channel. We can note that the study did not consider games specifically, however, it still demonstrates the potential of sensory stimulations.

Therefore, we can see that multi-sensory displays give game designers the possibility to share information differently with players.

2.1.3 MSVGIs Do Not Seem to Improve Players' Performance Significantly

[5] and [4] investigated the impact of MSVGIs on performance. Both studies revealed that the impact of those interfaces on the players' scores was negligible. Those results seem incoherent with a claim that both [5] and [4] did. Indeed, they noted that additional sensory cues increased the games' usability. However, following the Cambridge Dictionary [ ], usability means "the fact of something being easy to use, or the degree to which it is easy to use". So, an improved usability is supposed to result in a better performance, which was not the case in [5] and [4]. Yet, we can note that [4] noted a higher confidence in subjects playing MSVGIs, which may be what was meant in the term "usability".

Also, [5] used sensory cues for feedback. Therefore, the gaming experience was adaptive, as depending on the players' actions. And, Salah et al. [10] showed that adaptivity in games has a positive impact on players' performance. To do so, they compared the learning gain of adaptive and non-adaptive games and gave questionnaires to the players. Therefore, the neutral effect of MSVGIs on performance seems contradictory.

The neutral impact of MSVGIs on performance is also questioned by the findings of De Barros and Lindeman [11]. In their study, they evaluated the impact on performance of MSVGIs by asking participants to perform a robot teleoperation task with different interfaces and giving them questionnaires about their experience during and after the task completion. We note that the interfaces in this case were not described as games. However, we can observe some similarities with games: a relatively challenging goal to achieve in a virtual environment. And, [11] found that adding sensory cues can lead to an increase in performance, as long as it does not cognitively overwhelm players. Hence, a possible explanation for the neutral impact of MSVGIs on performance, noted by [5] and [4], is that, in those cases, the cues may be overwhelming for players. Another justification could also come from the nature of the cues, that is, the stimulated senses. Indeed, we will see in Section 2.2, that not all sensory cues have the same effects. Therefore, we may get different results stimulating different senses. However, if [11] focuses on the addition of audio cues, another study of De Barros and Lindeman [12] evaluates the impact of vibro-tactile displays. And [12] also found that such multi-sensory displays resulted in better performances. Finally, another explanation could reside in the fact that in both [11] and [12], the displays were not games. So, participants may have been more focused on the task and less on the enjoyment, contrarily to participants of study [5] and [4] who may have been distracted and hence less performing.

Therefore, we can see that MSVGIs does not seem to improve significantly players' performance but may have the potential to do so.

2.2 The Relation Between the Stimulated Senses and the Effects on Players

In this section, we will investigate the relation between stimulated senses and effects on players. In particular, we will see that the more senses stimulated, the more efficient are the MSVGIs. And we will observe that the stimulation of different senses can lead to different results.

2.2.1 Combining Different Types of Sensory Stimulations Lead to a Better Experience

Both [5] and [4] reported that the players were more satisfied when the games were giving diverse sensory cues. Indeed, [4] highlighted that players preferred the version of the game that used visual, auditory, and haptic cues, in comparison with modes that used visual cues, visual and auditory cues, or visual and haptic cues. [5] also argued that combining different types of sensory stimulations lead to a better experience for players. However, unlike [4], [5] did not expose players to many combinations. Indeed, they did not propose a version of the games that combined some but not all types of stimulation. That is, there are no "sound and fan", "sound and resistance" or "fan and resistance" modes.

Thus, it appears that the stimulation of different senses, combined, improves players' experience.

2.2.2 Different Sensory Stimulations Lead to Different Results

[5] showed that the version of the game with audio was more enjoyed than others (that were with resistance or fan). They highlighted that subjects "felt more in control" when there was sounds, correlation that had already been underlined by Jorgensen as cited by [5]. This gain in confidence was also noted by [4], which showed that the modes with auditory stimulations gave more confidence to players than the ones without this type of stimulation.

Moreover, [5] and [4] suggested that sound also plays a role in the level of focus of the players, helping them to be less distracted. Yet, both papers considered such possibilities as mere suppositions.

Furthermore, [5] noted that the version of the game with resistance, which adjusted the difficulty based on the players' actions, was less enjoyed than the versions with sound or fan. They explained it by the fact that such stimulation was associated with negative feedback "which may reduce feelings of competence".

Therefore, we can see that audio stimulations seem to be players' preferred type of stimulation, compared to haptic stimulations and resistance simulations.

2.3 The Importance of Design in MSVGIs

As mentioned in Section 2.1.3, [11] noted the risk to overwhelm players. Indeed, they underlined that multi-sensory displays can increase the cognitive load too much, which then can have a negative impact on players' performance. Therefore, in this case, in addition to the nature of the stimulations, their quantity and the importance of the information shared through those can influence players' experience.

This concern was also mentioned by [5] and [4], even though indirectly. Indeed, [5] noted the importance of not being "intrusive" and [4] suggested that a participant, that found the sound "annoying", "possibly felt overloaded with information". However, unlike [11], [5] and [4] did not investigate the cognitive load put on the players.

Finally, [7] reported that, in many studies, the narrative has a "neutral or negative effect on learning". However, they postulated that this result was more the consequence of design choices and managed to propose a game that had a positive impact on learning. We can then suppose that the neutral effects of MSVGIs on performance, found by [5] and [4], could be the

consequence of the design choices made, as it was the case for the neutral (or negative) effects of the narrative. This would mean that MSVGIs that improve players' performance may be possible and that having in mind the cognitive load may lead to better results.

Therefore, we can see that the design choices are crucial in MSVGIs, as there may be a risk to overwhelm players and negatively impact their performance and experience.

3 Summary & Conclusion

We have seen that MSVGIs have in most cases a positive impact on players and have the potential to change the way information is shared with them. Yet, if the effects of MSVGIs on immersion and motivation seem certain, the effects on performance are still discussed. Indeed, so far, the articles focused on MSVGIs found neutral effects, however, these results seem incoherent with papers studying non-game multi-sensory displays. Finally, we underlined the importance of design choices and in particular, we mentioned the necessity to keep in mind the cognitive load.

Further research may explore the impact of MSVGIs on performance, giving more importance to the cognitive load. More generally, the cognitve load put on players with MSVGIs could be studied. Also, a sense that has not been stimulated in the papers reviewed was the sense of smell. [5] explained such absence by the fact that this sense was not adapted to give sensory feedbacks, and hence won't be particularly motivating. Such a claim could be challenged and evaluated with empirical studies.

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